**Discussion**

Regularly occurring grassland wildfires are important to sustaining the vegetation that defines grasslands and the ecological niches and webs built upon them. As we permanently alter the climate and environment that formed grasslands due to a higher order cause, such as climate change, it is very likely that this will affect the frequency at which grassland wildfires occur. Therefore, the primary goal of our model was to discern the frequency of underbrush clearing necessary to sustain an apex predator population, and ultimately the integrity of a basic food chain, for different underbrush build up rates and regimes. In constructing our model, we assume that there is a regular rate of underbrush accumulation and that it is directly proportional to the probability that a fire will occur from a random event.

Using a linear regime for underbrush build up, we probed our model by varying either time between underbrush clearing events (hereafter referred to as time step) and the linear rate at which the probability of a fire increases with time due to underbrush accumulation. For underbrush build up rates larger than 1/120, we found that there is no reasonably large amount of time step that could sustain our apex predator population. However, it should be noted that the underbrush buildup rates 1/120 and 1/60 correspond to 0.8% and 1.6% increases in the fire probability per unit of time and a max fire probability of 25% and 50% for 30 units of time, respectively; this is likely unrealistic. We then pinpointed an underbrush build up rate of 1/240, which corresponds to a .4% increase in the fire probability per time and a max fire probability of 12.5% for 30 units of time. In comparing the different time step sizes for a buildup rate of 1/240, we were able to increase the final apex predator population size by decreasing the time step size, or in other words, increasing the rate of underbrush clearing events. For our linear regimes, we found that the lowest build up rate of 1/240 paired with the smallest time step of 5 is the only situation in which our model can sustain the apex predator population; despite this, a time step of 5 is logistically, and possibly financially, impossible. In every case, the number of fires increases with larger time step and a larger rate of underbrush accumulation, which is expected.

Following the linear underbrush build up schemes, we were interested in how other underbrush build up regimes may affect the time step size necessary to sustain the apex predator population. We constructed square root and polynomial underbrush build up regimes by normalizing the max fire probability to 12.5% for 30 units of time to match that of our 1/240 linear underbrush build up rate. We then varied time step discern whether there is a reasonably sized time step that can sustain our apex predator population in square root and polynomial underbrush build up regimes. For all time step sizes in our square root regimes, the apex predator population could not be sustained. This makes sense given that the max probability will be reached more quickly and that a larger number of fires might occur. Conversely, for all time step sizes in our polynomial regimes, the apex predator population was sustained as the max probability was reached more slowly with fewer fires occurring.

Overall, the conclusions that can be drawn from our model are limited and not surprising, but given accurate data describing the trends in underbrush build up and more precise parameters, our model could inform wildlife management approaches to deal with forest fires. The rate at which underbrush accumulates impacts the probability of a fire occurring and ultimately the number of fires that occur over a defined amount of time. If we were to establish a baseline for the number of fires that pass through a given area and amount of time, our model could estimate the rate at which underbrush builds up over time and how this rate might change with respect to environmental factors. In tandem with this estimation, our model could approximate the number of underbrush clearing events that may be necessary to generally sustain an apex predator population and the integrity of food webs that depend on a specific frequency of fires.

Our secondary focus is to investigate the ramifications on the ecosystem should the apex predator population go to extinction. This is the contrary to the primary focus in that we create a scenario to see what happens to the ecosystem when the apex predator is eliminated. We used the Allee Effect in our model as a mechanism for our apex predator to go extinct and in turn disrupt the food chain. The Allee Effect is the principle that there is a positive correlation between individual growth and population density. In other words when a population is less dense, its per capita population growth is lower as well. The Allee Effect was chosen since biologically it makes sense since eagles are known to travel separately would be sparsely located throughout the forest. The Allee Effect indicates that at a certain critical population size, the population will be unable to survive and be driven into extinction through a negative population growth rate. This synergizes very well with our wildfire component since the wildfire will aid in driving the eagle population below the critical population size and result in extinction.

For our model, we chose a critical population size of 20 given that our starting parameters for eagles was 100. The Allee Effect was supposed to influence (1) such that the growth rate of the eagle population would be positive when above the critical point and negative when below. Surprisingly, it was the Lotka-Volterra competition component that masked the Allee Effect in our data. The Lotka-Volterra competition between rabbits and eagles ended up causing our inherent growth rate of eagles to be smaller than its inherent death rate when the eagle population was still above the critical population size. Thus, the eagle population experienced negative growth beginning at way above the critical population size that ended up driving it to extinction in every model with a wildfire regime. Although the Allee Effect definitely contributed to the negative growth rate after the eagle population fell below the critical population size, it was unfortunately masked by the Lotka-Volterra aspect of our model overall. In order to fix this this problem in the future, the parameters to the overall equation must be adjusted, or the Lotka-Volterra competition component must be removed for the Allee Effect to be observed with more ease.